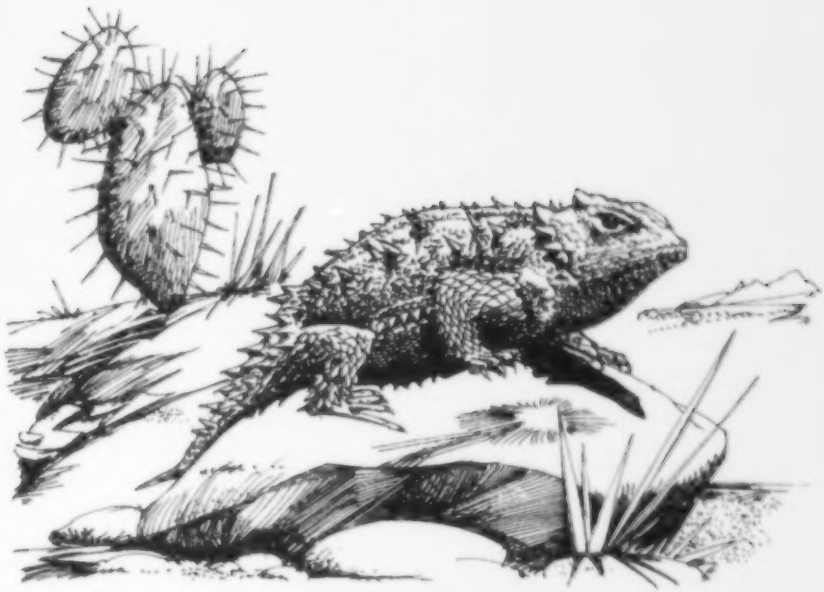
Fish & Wildlife Division

RESOURCE DATA AND SPECIES AT RISK SECTION

Status of the Short-horned Lizard (*Phrynosoma hernandesi*) in Alberta:

Update 2004



Alberta Wildlife Status Report No. 5 (Update 2004)

Alberta Conservation Association

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

105-01790/

Status of the Short-horned Lizard (*Phrynosoma hernandesi*) in Alberta:

Update 2004

Prepared for:
Alberta Sustainable Resource Development (SRD)
Alberta Conservation Association (ACA)

Update prepared by:
Janice D. James

Much of the original work contained in the report was prepared in 1997 by J.D. James, G.L. Powell and A.P. Russell.

This report has been reviewed, revised, and edited prior to publication. It is an SRD/ACA working document that will be revised and updated periodically.

Alberta Wildlife Status Report No. 5 (Update 2004)

June 2004

Published By:

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT
Fish & Wildlife

Alberta Conservation Association

Publication No. T/057
ISBN: 0-7785-2975-4 (Printed Edition)
ISBN: 0-7785-2976-2 (On-line Edition)
ISSN: 1206-4912 (Printed Edition)
ISSN: 1499-4682 (On-line Edition)

Series Editors: Sue Peters, Nyree Sharp and Robin Gutsell
Illustrations: Brian Huffman
Maps: Jane Bailey

For copies of this report, visit our web site at :
http://www3.gov.ab.ca/srd/fw/riskspecies/
and click on "Detailed Status"

OR

Contact:
Information Centre - Publications
Alberta Sustainable Resource Development
Main Floor, Great West Life Building
9920 - 108 Street
Edmonton, Alberta, Canada T5K 2M4

Telephone: (780) 422-2079

This publication may be cited as:

Alberta Sustainable Resource Development. 2004. Status of the short-horned lizard (*Phrynosoma hernandesi*) in Alberta: update 2004. Alberta Sustainable Resource Development, Fish and Wildlife Division, and Alberta Conservation Association, Wildlife Status Report No. 5 (Update 2004), Edmonton, AB. 27 pp.

PREFACE

Every five years, the Fish and Wildlife Division of Alberta Sustainable Resource Development reviews the general status of wildlife species in Alberta. These overviews, which have been conducted in 1991 (*The Status of Alberta Wildlife*), 1996 (*The Status of Alberta Wildlife*) and 2000 (*The General Status of Alberta Wild Species 2000*), assign individual species "ranks" that reflect the perceived level of risk to populations that occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily available sources of population data. A key objective of these reviews is to identify species that may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the general status exercise, and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are *At Risk* or *May Be At Risk* in the province, that are of uncertain status (*Undetermined*), or that are considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by the Alberta Conservation Association and the Fish and Wildlife Division of Alberta Sustainable Resource Development. They are intended to provide detailed and up-to-date information that will be useful to resource professionals for managing populations of species and their habitats in the province. The reports are also designed to provide current information that will assist Alberta's Endangered Species Conservation Committee in identifying species that may be formally designated as *Endangered* or *Threatened* under Alberta's *Wildlife Act*. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

EXECUTIVE SUMMARY

The short-horned lizard (*Phrynosoma hernandesi*), formerly known as the eastern short-horned lizard (*Phrynosoma douglassii brevirostre*), is Alberta's only native lizard species. Scattered populations of these small, well-camouflaged lizards are found on sparsely vegetated slopes of coulees and badlands in the extreme southeastern parts of the province. Short-horned lizards are on the list of species that *May be at Risk* in Alberta. They have also been designated a species of *Special Concern* by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This report was prepared as a review of current information relevant to the determination of the status of this species in Alberta.

In Alberta, short-horned lizards occur at the northern extreme of the species' range. Population size and trends have not been accurately assessed for the province, but the species apparently occurs at low densities relative to populations in Montana and other areas of the western United States. A recent provincial survey verified populations persisting at only one-third of documented historical locations. Populations in Alberta are generally found in areas that are free from extensive human disturbance, and are probably limited by natural factors such as climate and overwintering mortality. However, there are a number of human-related factors that may affect the viability of populations on a local scale. These factors include urbanization, motorized traffic, agricultural operations, and activities associated with oil and gas development.

Information from a recent survey suggested that where subpopulations of short-horned lizards persist in Alberta, they seem to be at approximately stable levels, and do not appear to be at immediate risk of extirpation. However, about one-third of previously reported sites could not be verified, suggesting an overall decline in the number of subpopulations persisting in Alberta. The small, isolated and sparsely distributed subpopulations in Alberta, coupled with potential threats to lizard habitat, render the species susceptible to future declines. More details about the susceptibility of this species to human impacts, such as habitat disruption from oil and gas development or urbanization, would help to clarify threats. Additional field research, especially brief annual surveys at a designated set of sites, is needed to better define this species' status in the province.

ACKNOWLEDGEMENTS

For the original 1997 report:
Thanks are due to Wendy Hodges (Texas Horned Lizard Conservation Society, University of Texas at Austin), to Laura Friis (B.C. Fish and Wildlife) for helpful comments, and to Dennis Flath (Montana Fish, Wildlife and Parks) for providing information on the species outside of Alberta. Also, the cooperation and interest of the Laidlaw family has been greatly appreciated over the years. The comments of Kelly Zamudio (University of California, Berkeley) were also pertinent. Leo Dubé (Alberta Natural Resources Service, Lethbridge) also provided access to additional information. Finally, thank-you's must also go out to Andy Didiuk (Canadian Wildlife Service), Steve Brechtel and David Prescott (Alberta Natural Resources Service) for commenting on the draft version of this report, Delinda Ryerson (Alberta Natural Resources Service) for editorial assistance, and Jane Horb for producing the maps.

Preparation of this report was funded by the Wildlife Management Enhancement Fund of Alberta Natural Resources Service and the Alberta Conservation Association.

For this update:
Thank you to Sue Peters, Nyree Sharp and Robin Gutsell for providing their considerable editorial talent. Thank you is also due to Dr. Tony Russell and Larry Powell for sharing their expertise and providing their astute suggestions to improve the document. Many thanks to Joel Nicholson (Medicine Hat) of the Fish and Wildlife Division of Alberta Sustainable Resource Development for his assistance with records from the Biodiversity/Species Observation Database (BSOD), and updates on other activities to date. John Taggart (Medicine Hat Fish and Wildlife) also provided insight into the current guidelines for oil and gas development in short-horned lizard habitat. Thank you to André Breault (Medicine Hat Public Lands) for his many contributions regarding industrial development in southeastern Alberta.

TABLE OF CONTENTS

PREFACE iii

EXECUTIVE SUMMARY iv

ACKNOWLEDGEMENTS v

INTRODUCTION 1

HABITAT 1

CONSERVATION BIOLOGY 2

1. General Biology 2
2. Body Temperature Regulation 3
3. Overwintering 3
4. Reproduction 3
5. Home Range and Movement 4

DISTRIBUTION 4

1. Alberta 4
2. Other Areas 7

POPULATION SIZE AND TRENDS 7

1. Alberta 7
2. Other Areas 10

LIMITING FACTORS 11

1. Agricultural Activities 11
2. Oil and Gas Exploration and Development 12
3. Urbanization 14
4. Roadways and Traffic 14

STATUS DESIGNATIONS 14

TAXONOMIC REVISIONS 14
STATUS HISTORY 15
CURRENT STATUS 15
1. Alberta 15
2. Other Areas 16

RECENT MANAGEMENT IN ALBERTA 16

TABLE OF CONTENTS cont.

SYNTHESIS 17

LITERATURE CITED 19

APPENDIX 1 Definitions of selected legal and protective designations. 25

APPENDIX 2 Generalized subpopulation localities with comments on approximate distribution and perceived population density 27

LIST OF FIGURES

Figure 1 Approximate distribution of the short-horned lizard (*Phrynosoma hernandesi*) in Alberta 5

Figure 2 Range of short-horned lizards (*Phrynosoma hernandesi*) in North America 8

INTRODUCTION

Horned lizards (*Phrynosoma* spp.) are small, well-camouflaged animals endemic to arid regions of western North America. The species found in Alberta is the short-horned lizard (*Phrynosoma hernandesi*), which, at the northern extreme of its distribution, ranges into the southeastern corner of the province (Russell and Bauer 2000, Stebbins 2003). The short-horned lizards that are found in Alberta were formerly classified as *Phrynosoma douglassii brevirostre*, or the eastern short-horned lizard. Early status reviews described the species as *Threatened** (Alberta Fish and Wildlife 1984), or placed it on the provincial "Red List" (Alberta Forestry, Lands and Wildlife 1991). Additional provincial reviews assigned the short-horned lizard to the "Blue List" of species that may be at risk in the province (Alberta Wildlife Management Division 1996). The most recent provincial status report assigns short-horned lizards the rank of *May Be At Risk* (Alberta Sustainable Resource Development 2001).

The primary objective of this report is to provide a thorough summary of current knowledge about this species in Alberta as background for a review of the status of the species within the province. Information about taxonomic revisions and recent provincial surveys has been updated.

HABITAT

The general ecological region occupied by short-horned lizards in Alberta is the Dry Mixedgrass Natural Subregion (Achuff 1992, Alberta Environmental Protection 1997, Alberta Natural Heritage Information Network 2002). This region, located in the southeastern corner of the province, is the warmest and driest part of Alberta, and one of the most climatically extreme areas of the Canadian prairies. The typically "continental" climate produces cold winters, warm summers and little precipitation (Alberta Natural Heritage Information Network 2002). Temperatures may fluctuate widely, both daily and seasonally. Frequent western winds ensure a high rate of evaporation (Alberta Natural Heritage Information Network 2002). The warm and dry conditions favour many native grass species, and the prevalence of short and mid-height grasses that dominate in this region led to the term "mixedgrass" for this assemblage. The most widespread association is the speargrass-blue grama (*Stipa comata-Bouteloua gracilis*) community (Alberta Natural Heritage Information Network 2002). Soils in the region are most commonly dark brown chernozems (Alberta Environmental Protection 1997, Alberta Natural Heritage Information Network 2002). A number of Great Plains species, such as greater sage-grouse (*Centrocercus urophasianus*), Ord's kangaroo rat (*Dipodomys ordii*), and prairie rattlesnake (*Crotalus viridis*), reach the northernmost extreme of their ranges in this part of Alberta.

In Alberta, short-horned lizards generally inhabit the sparsely vegetated, south-facing slopes along coulees and canyons, occupying the interface between the prairie grassland and the coulee bottom (Williams 1946; Soper 1949; Lewin 1963; Halladay 1965; Wallis 1976; Milner 1979; Powell 1982; Powell and Russell 1993a, 1998). Powell and Russell (1993a, 1998) distinguished three types of habitat for this species within Alberta: the "Milk River Basin" habitat, "Bearpaw" habitat and "North Marginal" habitat. In the Milk River Basin habitat type, lizards were found to occupy the ecotone between the short-grass prairie and coulee and canyon margins (Powell and Russell 1993a). McCorquedale (1965) associated the species with the Bearpaw shale outcrops, otherwise known as "juniper-dune" habitat (Powell and Russell 1993a). The Bearpaw, or juniper-dune habitat type, is located along the southern perimeter of the Cypress Hills plateau, east of the settlement of Manyberries. It consists of dunes, formed from exposure of

* See Appendix 1 for definitions of selected status designations.

the friable Bearpaw shale geological layer, and is commonly matted with creeping juniper (*Juniperus horizontalis*). The North Marginal habitat is so described because these most northerly of known populations, seemingly restricted to the rims of canyons and coulees with southern exposures, are thought to be less commonly occurring than populations further south (Powell and Russell 1993a). Short-horned lizards are not ubiquitous, even within suitable habitat, and have an interrupted distribution across southeastern Alberta (Powell and Russell 1998).

Vegetation is an important aspect of the microhabitat of short-horned lizards. Thinly vegetated areas with southern aspects appear to be preferred habitat (Powell 1982; Powell and Russell 1985a, 1998), although lizards have been found on east-, west- and some north-facing slopes as well (James 1997). In addition, lizards are occasionally found in open grassland areas, sometimes at considerable distances from the topographical variation they are generally associated with, and even in coulee bottoms; this is most common in Milk River Basin subpopulations (Powell and Russell 1998). Males may move further than females, but little is known about their habitat occupancy and preferences (A. P. Russell pers. com). As the habitat use of males is not well understood, it is difficult to make accurate statements delineating the habitat types required by this species (A.P. Russell, pers. comm.). The rotund shape and short legs of this species seem to render travel through thick vegetation difficult. However, adult female lizards appear to readily use vegetation as a source of shade and overnight thermal cover (James 1997). The lizards seem to require fine, friable soil into which they can burrow for overwintering. In Alberta, short-horned lizards occupy habitat types that are limited in occurrence. The amount of suitable habitat in this province appears to be relatively stable, although it is subject to disturbance or destruction in some areas, particularly the Bearpaw habitat (see "Limiting Factors", below).

CONSERVATION BIOLOGY

1. General Biology. – As lizards go, horned lizards, or Phrynostomatids, are very unusual. Camouflage is the primary means of predator evasion, and their mottled, sandy colouration and spiny skin blend in very well with the dry substrates they inhabit. Rather than running, or seeking refuge in burrows from predators, horned lizards generally refrain from movement, even when approached. Their remarkably cryptic form and habits serve them well as a means of avoiding detection.

Horned lizards, or phrynosomes, are sit-and-wait predators, dashing out and capturing prey that wanders within range (Pianka 1966). Most horned lizards primarily consume ants, and have specialized teeth and a large stomach capacity for the storage and digestion of this highly chitinous food item (Pianka and Parker 1975). Horned lizards are round and flat in body shape, with sharply spiked dorsal scales and short legs (Pianka and Parker 1975). Due to their aberrant body form, they exhibit a gait reminiscent of a toad's waddling walk—an attribute that likely helped gain them the common moniker "horned toad."

Short-horned lizards in Alberta are relatively small creatures, with the average adult female weighing about 18 g (Powell and Russell 1985a, 1993a) and reaching an average maximum snout-vent length (SVL) of approximately 70 mm. Adult males are considerably smaller, with an average maximum SVL of around 50 mm and weight of approximately 10 g (Powell and Russell 1993a). Short-horned lizards in Alberta are generally active from emergence in mid- to late April or early May until around mid-September (Laird and Leech 1980; Powell and Russell 1991b, 1992a, 1993a, 1998; James 1997). However, observations of emergence as early as 1 April have been documented, with activity being sustained, although much reduced, until late October or early November (Powell and Russell 1993b, 1994, 1998; James 1997). Female short-horned lizards in Alberta are

thought to live approximately five years, but the lifespan of males remains unclear (Powell and Russell 1985b, 1991a).

2. Body Temperature Regulation. – Horned lizards, like most reptiles, move between heat sources and heat sinks to control their internal body temperature within a preferred range—a characteristic behaviour among lizards, known as "shuttling" (Heath 1964, 1965; Powell and Russell 1985a). These lizards often bask in direct sunlight, a practice known as "heliothermy," in order to increase body temperature. They may flatten the body by extending the ribs, and adjust their position, orientation and tilt to increase the surface area exposed to incident radiation (Heath 1964, 1965). Thigmothermy, or the gaining of heat from an object, such as a rock, has also been observed in these lizards (Heath 1965, James 1997). To cool down, individuals may seek shade, alter their orientation, narrow the body profile, and may even burrow into the substrate (Heath 1964, 1965). Lizards studied in southern Alberta generally remained under an insulating cover overnight (James 1997).

Prieto and Whitford (1971) found that short-horned lizards in the southwestern United States withstood a greater temperature range, and had more variable body temperatures, than a co-occurring species of horned lizard. They also found that short-horned lizards exhibited a lower critical thermal minimum temperature, a lower critical thermal maximum and had a lower preferred body temperature than another species of *Phrynosoma*. In Alberta, short-horned lizards have been found to tolerate a broad range of body temperatures (James 1997, Powell and Russell 1985a), and likely possess the ability to withstand freezing—a trait which is probably vital to their survival in such a severe environment (Powell and Russell 1994, 1996c, 1998). The median body temperature maintained by lizards in Alberta during the active part of the day is 32.9° C (Powell and Russell 1985a). The mere presence of this species in the climatically challenging environment of southern Alberta is testament to the remarkable physiology of these animals.

3. Overwintering. – Initially, the overwintering dens of short-horned lizards in Alberta were hypothesized to be within the deep crevasses of the rock comprising the Judith River formation that underlies much of the habitat of these lizards in Alberta (Powell and Russell 1992a, 1992b). However, radiotelemetry used to locate individuals in their hibernacula led to the discovery that individuals simply excavate a relatively shallow burrow, approximately 10 cm beneath the surface, in the loose soil of a south-facing slope, perhaps relying on snow cover for insulation (Powell and Russell 1994, 1996b; James 1997). Overwintering mortality and mortality due to early and late seasonal extremes have been suggested as possible reasons for the low population densities of these lizards in Alberta (Powell and Russell 1994, 1996b).

4. Reproduction. – Short-horned lizards are viviparous—they bear live young that have been carried to term internally (Blackburn 1982). Populations in Alberta exhibit marked sexual size dimorphism, with adult females growing much larger than males (Powell and Russell 1985b). Mating in an Alberta population has been observed to occur in mid- to late May (James 1997). Females reproduce annually, producing one clutch of young per year (Powell and Russell 1991a). Males may become sexually mature in their first year; females breed in their second year (Powell and Russell 1985b), bearing between 6 and 13 neonates of an even sex ratio (Powell and Russell 1991a). In Alberta, all females undergo parturition within a short time period near the end of July (Powell and Russell 1991a). Neonate survivorship is believed to be low—offspring weigh around 0.7 g at birth and are approximately 24 mm SVL, making them an easy target for almost any vertebrate predator that might happen across them (Pianka and Parker 1975, Powell and Russell 1991a). The reproductive effort appears to take a great

physiological toll on females, and they appear gaunt and weak following parturition (Powell and Russell 1991a, James 1997).

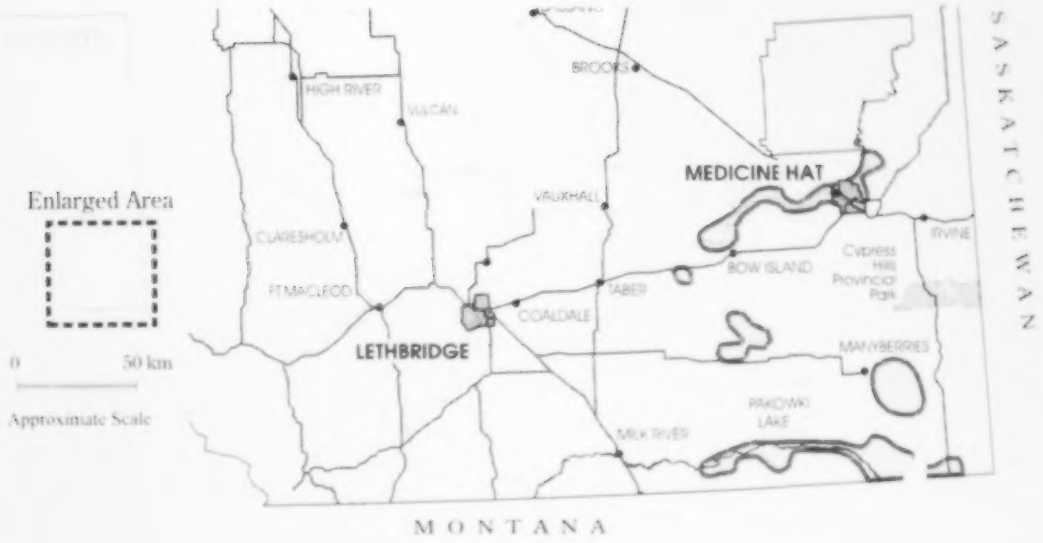
5. Home Range and Movement. – Short-horned lizards in Alberta that were monitored by means of radiotelemetry, for periods of from one to three months, were recorded to have home ranges varying from 4.4 m^2 to 2400 m^2 (Powell and Russell 1993b, 1994). Later fieldwork found a maximum home range could be up to approximately 4000 m^2 (Powell and Russell 1996b). As well, some evidence suggests that although temporary home ranges can be relatively small, the total home range areas used by short-horned lizards in Alberta may be larger than previously believed (Powell and Russell 1993b, 1994, 1996b; J. James, unpubl. data). James (unpubl. data) found that some female short-horned lizards moved significant distances prior to mating (more than 100 m over a one-week period), following parturition (usually less than 50 m), and again prior to hibernation (as far as 266 m over one week). The tendency of these small lizards to travel substantial distances, perhaps even a kilometre or more, may have been underestimated in the past.

DISTRIBUTION

1. Alberta. – The short-horned lizard is the most northerly occurring of all horned lizards (Baur and Montanucci 1998, Russell and Bauer 2000, Sherbrooke 2003, Stebbins 2003), with the northernmost limits of its distribution extending into southeastern Alberta (Russell and Bauer 2000). These lizards are found only in the southeastern corner of the province, with populations located in apparently disjunct zones along the Milk and South Saskatchewan rivers and around the Chin Coulee, Forty Mile Coulee, and Pakowki Lake drainages (see Figure 1; Powell and Russell 1998). The seemingly clumped distribution may, in part, be a reflection of the limited records for this species over much of the potential range (Powell and Russell 1991b). Assessing the presence of the species, even in areas of confirmed captures, is often difficult because of the low population densities and cryptic habits of these lizards.

Short-horned lizards are known from 74 sections of land in southeastern Alberta, as determined from museum specimen records, previous reports and provincial BSOD records. Of these, the available habitat on six sections has been rendered unsuitable or was of dubious authenticity, leaving 68 sections, or 176.12 km^2. An example of habitat rendered unsuitable would include the Grassy Lake site, where the habitat remaining is a small fragment surrounded by cultivated fields and irrigation canals, and any population that may have once inhabited the site is presumed extirpated (Powell and Russell 1992a). Recent survey efforts verified the presence of short-horned lizards on approximately one-third of searched sections, giving a maximum verified estimate of the area of occupancy of 22.4 sections or 58.12 km^2 provincially. There are five main areas around which lizard subpopulations are loosely scattered (Figure 1). Regions in which short-horned lizards were recorded historically include the following: the areas along the South Saskatchewan River, the Chin Coulee/ Forty Mile Coulee region, the Manyberries "badlands" (Bearpaw habitat), along the Milk River proper, and in the tributaries of the Milk, near the Onefour Federal Research station. Within these five main areas, it appears that there are a number of isolated subpopulations.

For the population along the South Saskatchewan, records suggest there are approximately five isolated subpopulations. Of those subpopulations, the habitat for one has been apparently degraded by adjacent cultivation and irrigation, and a second subpopulation, within the city of Medicine Hat, is presumed to be negatively affected to some degree by, if not already lost to, the surrounding roads, traffic, and urban developments. Of the remaining three subpopulations known along the South Saskatchewan, at least two occur in areas where



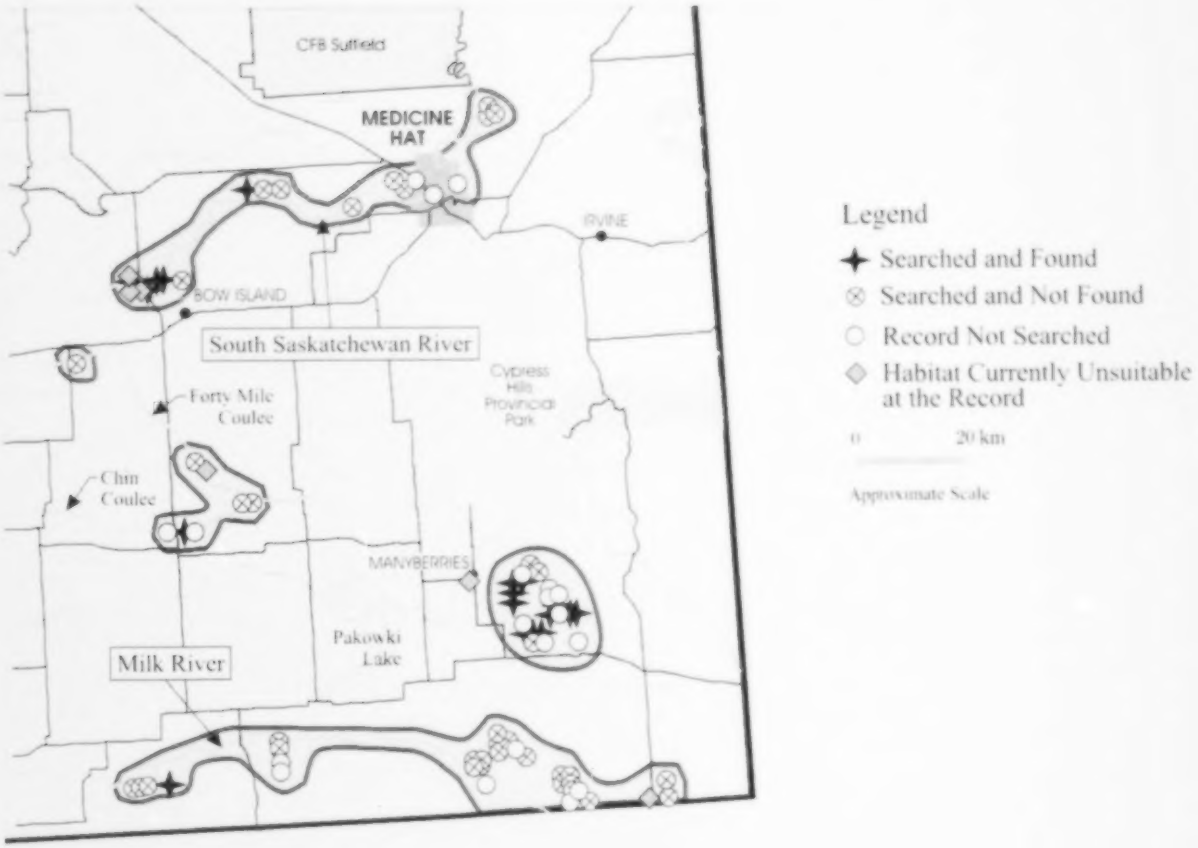


Figure 1. Approximate distribution of the short-horned lizard (*Phrynosoma hernandesi*) in Alberta. The outlined and shaded regions indicate areas where subpopulations may be found. This map was created using records submitted by various sources to the Biodiversity Species Observation Database, which is maintained by Alberta Sustainable Resource Development. Records were confirmed during surveys in 2001-2002.

a prevalent activity is oil and gas development, which may pose a significant risk to these subpopulations. Records indicate there were three subpopulations in the vicinity of the Chin and Forty Mile coulees. One of these appears to have been lost to dam and irrigation development (Powell and Russell 1992a). Another separate subpopulation, presumed to have been south of Grassy Lake, is also considered extirpated as a result of habitat reduction and fragmentation (Powell and Russell 1992a). Along the Milk River and its tributaries, approximately five isolated subpopulations were originally documented. Of these, one subpopulation is presumed lost to cultivation (i.e., Wildhorse site), and of the remaining four, three could not be verified, in spite of repeated efforts during the recent surveys. Where habitat has been radically altered, or has been converted to cultivation, populations should be considered permanently lost.

The Manyberries badlands (Bearpaw habitat) should probably be considered as one large subpopulation, and contains by far the most significant numbers of these animals in the province according to the 2001 survey data. It, too, has been and continues to be subjected to intensive oil and gas development. Development in the Manyberries badlands is of particular concern for this species, because of the quantity and quality of the habitat and the proportion of the provincially—and nationally—significant population that resides there. The habitat available to the lizards in the Manyberries Hills area is invaluable for lizards in Alberta as it contains a large expanse of appropriate substrate and highly diverse microhabitats within the juniper-dune habitat type. The considerable size of this contiguous habitat tract, in combination with its highly diverse nature, has made possible the apparently relatively large and dense lizard population, as evidenced in recent surveys (James 2002). Damage to the juniper dunes from development could lead to irreversible impact on the lizard, as the dunes embody the substrate and microhabitats that are critical for lizard success. Once disturbed, these subtleties of habitat are not easily mitigated and disturbances are slow to recuperate. The unique diversity of the juniper-dune habitat type is unrivalled by the habitat types available along the major drainages, and higher capture rates for lizards likely reflect that fact.

Comparatively, all other habitats used by short-horned lizards in Alberta are primarily long strips of suitable habitat along drainage valleys, often intersected by roads and more readily influenced from all sides by human activities. Linear habitat fragments are, because of their shape, more susceptible to outside influences—or "edge effect" —than are larger, more circular-shaped habitat areas (Hunter 1996). As the habitat in Alberta outside of the Manyberries badlands is essentially linear, it is probable that human impacts, both direct and indirect, have already influenced these populations, perhaps resulting in lower populations. This could be a significant factor in the low capture rates in the remainder of the species' range.

These relatively isolated "subpopulations" are at considerable distance from one another, with the nearest of them—the Manyberries badlands sites and the eastern Milk River sites (Onefour, Lost River)—being an estimated 15-20 km apart. It is extremely unlikely that short-horned lizards would be capable of traversing such distances. The probability of one subpopulation recolonizing an area where another subpopulation has been lost is exceedingly low, because of the distances involved, the small size of the animals, and the low densities of all subpopulations. The chances of recolonization are further reduced by considering the negative effects of large-scale human influences on the landscape such as roads, cultivation and irrigation, which would additionally inhibit any successful migration. Those sites next nearest to the Manyberries badlands sites are probably the Chin Coulee/Forty Mile Coulee sites, which are about 44 km to the northwest. The most northern sites, along the South Saskatchewan

River, north of Medicine Hat, are at least 130 km from the southernmost sites along the Milk River and its tributaries. The breadth of the range in the province is approximately 87 km from the easternmost sites to the most western. The large distances between subpopulations almost certainly prohibit exchange of individuals between them.

2. Other Areas. – Horned lizards are endemic to arid and semi-arid regions of west-central North America. There are 13 species of horned lizards (Montanucci 1987, Sherbrooke 2003) distributed from the northwestern corner of Guatemala to southern Canada (Reeve 1952, Pianka and Parker 1975, Baur and Montanucci 1998, Sherbrooke 2003, Stebbins 2003). Short-horned lizards have the broadest range of all horned lizards in geographic, latitudinal and altitudinal terms (Smith 1946, Reeve 1952, Heath 1965, Montanucci 1981, Baur and Montanucci 1998, Russell and Bauer 2000). They inhabit mountainous areas, plains and arid uplands within their distribution from Chihuahua and Durango in Mexico, to the southernmost regions of Alberta and Saskatchewan (see Figure 2; Smith 1946, Reeve 1952, Montanucci 1981, Russell and Bauer 2000, Sherbrooke 2003, Stebbins 2003). As with many species on the Canadian prairies that have range-marginal populations, the proportion of the range of this species extending into Alberta is small—likely five percent or less of the species' total distribution (Figure 2).

In Saskatchewan, short-horned lizards have been recorded in the extreme south-central portion of the province along the drainages of the Frenchman and Poplar rivers—tributaries of the Missouri River system (Powell and Russell 1993a, 1996c; Powell et al. 1998). In a recent survey of Grasslands National Park, lizards were found in juniper-dune habitat along the Frenchman River valley in the West Block (Powell et al. 1998). The East Block population, which was located on more vegetated slopes above alkaline alluvial flats, was found to be quite limited in size (Powell et al. 1998). Captures in Saskatchewan have been made exclusively in Grasslands National Park and were limited to within approximately 30 km of the U.S. border in the West Block and 6 km of that border in the East Block, indicative of the range-marginal status of these populations (Powell et al. 1998).

POPULATION SIZE AND TRENDS

1. Alberta. – All previous estimations of changes in population were subjective extrapolations from fieldwork done by G. L. Powell (University of Calgary). The incidental observations of local residents also provided an indication of the relative abundance of short-horned lizards in some areas (Powell and Russell 1993a). In Alberta, historical population densities of short-horned lizards have been repeatedly described as low (Powell 1982; Powell and Russell 1985b, 1991b, 1992a,b, 1993a,b, 1994, 1998).

Powell and Russell (1992a) suggested that the overall population of short-horned lizards in Alberta appeared to have declined between the time of the early fieldwork done by Powell in 1978-1982 (Powell 1982) and their fieldwork done in 1991 (Powell and Russell 1992a). The conclusions of population decline were tentative, owing to poor weather in the field, limited manpower, and the small number of populations for which comparable information was available from previous years. Nevertheless, field searches in 1991 yielded much lower capture rates than were documented 11 years earlier, with captures made in 16 of the 28 known areas. The authors proposed that the prolonged drought over much of that period might have been responsible for the apparent decline in population size. Reduced insect abundance, resulting from the general depression of productivity during the drought, could have acted to decrease fecundity in short-horned lizards, resulting in a cumulative population decline over the region (Powell and Russell 1992a). This is perhaps the most direct

Figure 2. Range of short-horned lizards (*Phrynosoma hernandesi*) in North America (modified from Stebbins 2003).

evidence currently available that short-horned lizard numbers likely fluctuate, at least somewhat, along with environmental variations. The extent to which such fluctuations may occur is not known.

2001-2002 surveys: An effort to survey all recorded short-horned lizard capture sites in Alberta was undertaken over the field seasons of 2001 and 2002. Surveys were initiated and funded by the Fish and Wildlife Division (Lethbridge and Medicine Hat) of Alberta Sustainable Resource Development and were overseen by J. James. The objectives of the 2001-2002 surveys were first to verify the presence of short-horned lizards on all land for which they had previously been recorded within Alberta. Second, it was expected that this information would then be used to derive some estimate of population levels in the province. Finally, an evaluation of population trends for this species was also requested, if feasible. As it was not possible to search all sites in 2001, it was anticipated that searching the remaining sites in 2002 would complete the task. However, poor weather conditions throughout the appropriate time frame hampered all efforts in 2002, and only five captures were made (James 2003). As a result, most of the data analysis was based upon those data collected in 2001. See James (2002, 2003) for full details of the survey efforts.

The 2001 field season was successful, yielding 125 captures on 16 sections, with a total of 44 sections searched over 19 days in late July and August (James 2002). When data from both years were pooled, 130 lizards were captured on 19 sections across the known range. In total, 59 sections were searched, in whole or part, over the survey period. Of the historically recorded sections that were searched (48), lizards were verified on 16 (33.3 %) of them. From the more robust 2001 dataset, it was estimated that, on the land where lizards were captured, they occurred at an average density of approximately 2 individuals/ha or 200 lizards/km^2 of *suitable* habitat. From historical records, excluding those sections that have had the suitable habitat destroyed or seriously altered, the remaining theoretical distribution of short-horned lizards *in Alberta is about 176.12 km^2 (68 sections).* Of course, individual lizards are not evenly distributed across entire sections of land, as they are primarily associated with the less common grassland/coulee breaks, or juniper-dune habitat areas that generally make up only portions of each section. As such, it may be a reasonable estimate that suitable habitat likely constitutes less than half of the total area. Therefore, if it is presumed that only half of the total area of the historically recorded sections would be suitable habitat, then a total of 88.06 km^2 (8806 ha) remains. If only one-third of these areas continues to be inhabited by lizards, as suggested by the 2001 survey results, then this leads to an estimated 29.35 km^2 (2935 ha) remaining as occupied suitable habitat. At the estimated density of 200 animals per km^2 (2 lizards/ha), this leads to an estimated population of about 5871 individuals in Alberta. Because only 69% of survey captures were mature adults, the reproductive population may be even lower, at 4051 individuals. This estimate probably represents a provincial reproductive population minimum.

A reasonable maximum might be calculated by noting that the search effort likely missed a certain proportion of lizards actually present. If it is presumed that the search efforts located only half of the available animals, which is entirely possible (implying a density of about 4 lizards/ha), and that they remain present on all of the remaining suitable habitat of 88.06 km^2, even though we missed them, then the total population in the province could be as high as 35 224 individuals (24 305 if only adults are considered). If the same calculation technique is applied to isolated subpopulations to give an approximate range for potential population size, then the smallest of these, at two sections, could contain between 518 and 1036 individuals (357-715 adults). The largest subpopulation, in the

Manyberries Hills (Bearpaw habitat) area, recorded on 21 sections, could comprise between 5439 and 10 880 individuals (3753-7507 adults). This single subpopulation in the Manyberries area (Bearpaw habitat) may therefore contain nearly one-third of the entire Alberta population. All such extrapolations are, of course, laden with questionable assumptions, and must be viewed as extremely tentative.

Although lizards were not captured on roughly two-thirds of the historical sections searched, this does not prove their absence, but does perhaps suggest that some degree of range contraction may have already occurred (James 2002, 2003). This was of particular concern for those populations in most of the Milk River, Lost River and Onefour areas, and north of Medicine Hat, where no captures were made despite a concerted effort under good conditions. Possible explanations for lower than expected capture rates could include localized population reductions or losses, perhaps as a result of the severe drought conditions during and preceding 2001, or some localized, weather-related catastrophe, such as an extreme cold spell during the parturition period or that could have compromised the lizards' ability to complete preparation for hibernation.

A gauge of population trend was approximated from the 2001 capture rate. Overall, the capture rate (2001 data only) was 2 hours, 20 minutes per capture—similar to Powell's estimate of about 2-3 hours per capture (G. L. Powell, pers. comm.). From this evidence it was surmised that population levels are likely to be roughly stable in those areas in which short-horned lizards persist. Previous suggestions that populations may be declining have been based mainly on anecdotal evidence, such as the irregularity of observation of these lizards by locals, as well as the observations of G. L. Powell (Powell and Russell 1993a). These observations of apparent decline may well be valid, particularly considering the low verification rate (number of captures) for this species in 2001-2002.

Phrynosoma populations in general have been described as low in the United States (Pianka and Parker 1975), but it is suspected that the densities of short-horned lizards in Canada are notably less than those in areas further south (Powell and Russell 1996c). For example, in most areas where short-horned lizards are found in Alberta, a good field day is one during which two to four lizards are captured over the course of an eight-hour search in prospective habitat. In contrast, the capture rate for pygmy short-horned lizards in northern California is considerably higher, and perhaps 20 or more may be encountered per day (K. Zamudio, pers. comm.). Powell et al. (1998) found lizards to be less common in Saskatchewan than at some Alberta sites. Capture rates in Grassland National Park in 1995 and 1996 varied from 1.2 hrs/capture (West Block) to 25 hrs/capture (East Block)—a considerable range (Powell et al. 1998).

It appears that short-horned lizard populations in Alberta have declined over the past 20 years. Recent survey efforts in 2001-2002 failed to locate individuals on approximately one-third of the previously recorded sites. Previous survey work suggested that populations in 1991 were lower than those in 1980 (Powell and Russell 1992a). On those sites where lizards were located in 2001-2002, individuals were captured at a rate comparable with past capture efforts, implying a relatively constant population in those areas where they were relocated. The low rate of relocation, combined with the relatively stable capture rate at those locations where populations were verified, suggests that the decline is linked with individual subpopulations. If declines appear to be correlated with individual subpopulations, then this in turn suggests there is some sort of localized effect on those subpopulations.

2. Other Areas. – Little is known of the population size of short-horned lizards in Saskatchewan, and although recent investigations have provided improved baseline

information, no confident comments regarding population size or trends can be made (Powell et al. 1998). The 1995-1996 surveys in Grasslands National Park suggested that lizards were more difficult to find at both locations in Saskatchewan compared with previous experience in Alberta (Powell et al. 1998; G. L. Powell, pers. comm.). The short-horned lizard in Montana is described as "...widely distributed (but somewhat localized) in eastern Montana" (Reichel and Flath 1995). The proximity of the nearest subpopulations of short-horned lizards in Montana to those in Alberta is not well documented.

LIMITING FACTORS

Like all Great Plains species, short-horned lizard populations in Alberta are affected by both natural and human-related influences. The first limiting natural factor for short-horned lizards in Alberta is climate. Short-horned lizards in Canada are at the northernmost limit of their range (Russell and Bauer 2000, Stebbins 2003). As such, climatic constraints likely play a key role in the distribution of these lizards in the province (Powell and Russell 1991a, 1998). Predation may also be a natural limiting factor for lizard populations in Alberta. However, losses due to predation are presumed to be secondary to climatic constraints, because the small size, low density and cryptic habitats of these lizards would not likely make them the primary prey choice for many predators, although they may be taken opportunistically by a wide range of generalist predators (Powell and Russell 1996c).

The remainder of this section focuses on human-related impacts on short-horned lizards in the province. In Alberta, the species tends to occupy areas that are not agriculturally productive, nor commonly visited by many people. Powell and Russell (1993a, 1998) listed grazing, cultivation, oil and gas exploration, and urbanization as potentially limiting human impacts for the short-horned lizard in Canada. The authors noted that these factors vary in importance within the range of the lizard in Canada, and that more is known about the effects of these activities in Alberta than in Saskatchewan.

1. Agricultural Activities. – Grazing is the most common land use over most of the area in which lizards are found in Alberta. According to Powell and Russell (1993a), grazing cattle are unlikely to have much influence on short-horned lizard populations, and their effect is probably comparable to that of bison (*Bison bison*) in the past. In fact, Reynolds (1979) found that pygmy short-horned lizards (*Phrynosoma douglasii*) in Idaho appeared to respond positively to the reduced vegetative cover caused by grazing. Powell and Russell (1993a) note that the only aspects of cattle grazing likely to have deleterious effects are physical damage near coulee edges, and the seeding of invasive species such as crested wheatgrass (*Agropyron cristatum*)—an introduced grass which may restrict the movements of short-horned lizards. These lizards tend to inhabit areas that cattle do not prefer, such as steep hillsides and juniper dunes. Other livestock-related activities are generally limited in scope or occur away from the habitat occupied by the lizards. Therefore, the overall impact of cattle grazing on short-horned lizard populations in Alberta is thought to be relatively low (Powell and Russell 1993a).

The second most common human activity over the range of short-horned lizards in Alberta, as listed by Powell and Russell (1993a), is cultivation and its related activities. Once again, lizards inhabit areas that are not likely subjected to cultivation, but the extent of use of such "marginal" land depends on individual landowners (Powell and Russell 1993a). Powell and Russell (1993a) concluded that although cultivation close to coulee edges would eliminate habitat, agriculture in general was not a significant limiting factor for these lizards in Alberta, as the lizards tend to inhabit "marginal" lands that are not well suited to cultivation. One exception, which may have contributed to the extinction of at least one population, involved the creation of an irrigation reservoir at the Forty Mile

Coulee site and the consequent flooding of the surrounding hillsides, which were apparently previously inhabited by short-horned lizards (Powell and Russell 1992a, 1993a).

Another aspect of the effects of modern agriculture on short-horned lizards in Alberta that was only briefly discussed by Powell and Russell (1993a) is the potential impact of insecticides. Short-horned lizards consume ants, grasshoppers, crickets and beetles (Powell and Russell 1984). Agricultural pesticides, although not commonly used on an annual basis over the region, may be used heavily in some years to control insects, particularly grasshoppers, when populations increase to destructive levels, especially in areas near croplands. The possibility exists that these chemicals may be used even in some of the more marginal agricultural areas inhabited by these lizards. The probability of direct ingestion of poisoned prey would increase greatly under such circumstances, and such ingestion would likely be detrimental, if not fatal, to such small predators. Additionally, the available prey base would also presumably be decimated, which would also be anticipated to have negative effects on lizard populations.

2. Oil and Gas Exploration and Development. – The oil and gas industry is active within much of the range of the short-horned lizard in Alberta, and particularly so in the Manyberries area (Powell and Russell 1991b, 1992a,b, 1993a, 1996b; Smith 1993). Powell and Russell (1993a) noted that although the installation of pipelines was likely to cause some disturbance for short-horned lizard populations, there appeared to be no great lasting influence. Exploration and development, however, may have more serious impacts (Powell and Russell 1993a, Smith 1993).

Powell and Russell (1993a) noted that the tracks left by vehicles have been observed to be used by short-horned lizards as travel routes through grassy areas, exposing the lizards to being run over by other vehicles following the same track. At least one short-horned lizard has been recorded as run over on an oil access roadway (G. L. Powell, pers. obs.). The tracks themselves also promote access by other vehicles, by attracting recreational users. Field work in the Manyberries badlands area over the 2001 season (James 2002) also found that notable numbers of lizards were sometimes associated with oil and gas development roadways.

The preparation of land for the set-up of drilling rigs, especially where the topsoil is removed, results in significant destruction of suitable habitat. The creation of service roads for well access causes even more loss of habitat, cumulatively, than do the well sites themselves. The increase in associated traffic also poses a threat to any lizards that venture onto the roads. Erosion by wind and water may cause further harm to disrupted areas of habitat, further degrading such areas (Powell and Russell 1993a). These disturbances amount to a significant threat to short-horned lizard habitat, especially when considered cumulatively across the range of the species in Alberta. The juniper-dune (Bearpaw) habitat type is particularly vulnerable to such damage, and has been and continues to be subjected to an astonishing amount of disturbance from oil and gas exploration in the Manyberries area (Powell and Russell 1991b, 1992a,b, 1993a, 1996b; Smith 1993).

The degree to which this area has already been affected is not easily quantified. A.Breault (pers. comm.) estimates that approximately 20% of the appropriate habitat types available in the Manyberries badlands area already have "...developments ranging from roughly 3 to 11 wells per section, 1 to 4 access road dispositions and 2 to 6 pipeline dispositions per section." It is impossible for those outside of the energy industry to estimate what the potential for further development is in any given area, as such information is closely guarded by companies. Given past experience, it seems reasonable to

expect further developments, especially in the face of ever-increasing levels of oil and gas demands. Because this area is probably the most important for short-horned lizards in Alberta, and probably retains the largest subpopulation, the impact of this development is significant for the species in Alberta. Recent attempts to lessen industrial damage to the habitat areas have probably been helpful by reducing the size and intensity of industrial traffic through known short-horned lizard habitat and by reducing the need for the clearing of land prior to drilling in some cases.

Currently, industrial development in southeastern Alberta is often described as "heavy", with annual increases for development in the area of roughly 200 applications for oil, gas, access roads, pipelines and seismic operations (A. Breault, pers. comm.). The possibility exists that shallow gas extractions at a density of 16 wells per section, or coal bed methane at 32 well sites per section plus eight compressors, could be put into service in this region (A. Breault, pers. comm.). A. Breault and J. Taggart (pers. comm.) have also pointed out that this prediction is for 16 wells per section *per development company*, and that multiple companies may pursue different geological layers from the same land surface, leaving open the possibility of far more than 16 well sites per section. Such extreme development density has not yet come to pass in this area, and no coal bed methane development projects have yet been undertaken, but both are legal possibilities. Further, the pressure to develop is expected to intensify with increasing demand for hydrocarbons.

Short-horned lizards are strongly associated with the sloped hillsides associated with the ecotone between valleys, or badlands, and upland grasslands. Recent efforts to use a model to create a map of the habitat potential for short-horned lizards within the Milk River drainage of southeastern Alberta emphasized the limited area and isolated nature of the available habitat for this species (R. Quinlan, pers. comm.). As a result of drilling restrictions within valley bottoms, these "valley breaks", as they are sometimes called, are attractive for industrial infrastructure, such as well sites and roads (R. Quinlan, pers. comm.). This apparently enables directional drilling under valley bottoms—thus the attraction to be as close as possible to the valley edge (J. Nicholson, pers. comm.). This perhaps intensifies the appeal for industrial activity and associated roadways within those sloped areas favoured by lizards, further reducing habitat integrity.

Concern about the cumulative effects on this species of ongoing development in the Manyberries badlands area has been expressed several times in the past (e.g., Powell and Russell 1991b, 1992a,b, 1993a, 1996b; Smith 1993). The inconsistency of relatively high lizard numbers in an area that has already undergone a great deal of development does seem somewhat of a paradox and may appear to suggest that the species is not harmed by the said developments. To the contrary, it is likely that at least so far, lizard populations have rejuvenated themselves here more readily than in other disturbed areas because of the large size of the source population and the large, relatively contiguous tract of suitable habitat.

If the collective level of development reaches such a point as to begin to cause the species to decline in the Manyberries badlands, this would be disastrous for the species' long-term presence in Alberta. Given current and future interests in oil and gas resources, as well as in other potentially viable resources, it is certain that further developments in the Manyberries badlands will be attempted. The means by which this exploration occurs has the potential to critically damage this habitat. Given that the interaction of the species with development is not well understood, but is certainly negative—being that the lizards are small, relatively immobile and ground-dwelling—and that this is the location of the most significant population

of this species remaining in the province, it is prudent to err on the side of caution when evaluating proposed development in the area.

There is reason to believe that the Manyberries badlands area will continue to be a target of resource extraction. An application has been made in the Manyberries badlands for surface-mining operations of ammonite, a semi-precious "mother-of-pearl" stone retrieved from the inner lining of the fossilized shells of ancient sea creatures called ammonites. Recently, an application has also been put forth for the mining of humate, a precursor of coal and an organic material used in soil reclamation and composting, among other things (J. Nicholson, pers. comm.). Approvals for the preliminary exploration of this resource have been accepted (J. Nicholson, pers. comm.).

3. Urbanization. – Urbanization does not directly affect a large proportion of short-horned lizard habitat in Alberta. The populations that have been affected are primarily those near and within the city of Medicine Hat and the town of Redcliff. In this area, urbanization may affect short-horned lizard populations directly, through the loss or fragmentation of habitat, predation by domestic pets, and collection by inquisitive children or adults, or indirectly, by the danger of being run over by traffic of various sorts (Powell and Russell 1993a, 1998). The extent of the effect of urbanization remains unknown because of the paucity of information regarding exact locations of populations before the growth of the city (Powell and Russell 1993a).

4. Roadways and Traffic. – Roadways and the use of motorized vehicles such as dirt bikes, all-terrain vehicles and even trucks over the home range of the short-horned lizard may have important ramifications for local populations. Short-horned lizards may be more vulnerable to road kill than previously thought if they attempt to migrate across roads to previously contiguous habitat areas. Some female short-horned lizards were recently documented to move considerable distances over relatively short periods of time (J. James, unpubl. data), and males are suspected to move substantial distances as well. A.P. Russell (pers. comm.) notes that if males venture farther and more often than females, then they have a higher probability of being exposed to predators and are more likely to be killed. He also points out that males may move away from the coulee rims and extend into grasslands, but that little is known of what males actually do and where they go. There is also a possibility that trucks and other vehicles used by ranchers and the general public within the range of these animals present a danger, as the lizards' small size and habit of remaining motionless until approached likely reduces their ability to avoid oncoming vehicles.

The use of recreational vehicles in the coulees and river valleys that the lizards occupy is also a potential threat to some short-horned lizards. The extensive use of dirt bikes on some hillsides causes extreme damage to vegetation and soil stability over a considerable area, and increases the possibility of direct mortality of lizards. All-terrain vehicles, as well as trucks, are also commonly used in the field areas near or within short-horned lizard ranges, and may present a danger to these lizards. Beauchamp et al. (1998) found that flat-tailed horned lizards (*P. mcallii*) in southern California were negatively affected in an area heavily used by off-highway vehicles. One incident of a short-horned lizard being run over and killed by an all-terrain vehicle has been noted (anecdotal report by M. Laidlaw, July 1996). As the lizards are very small and cryptic, the likelihood of them being noticed by drivers, even after having been run over, is extremely low.

STATUS DESIGNATIONS

TAXONOMIC REVISIONS

Since the 1997 edition of this report, the taxonomic status of short-horned lizards has been revised significantly, based on both genetic and morphological characteristics. The

subspecies found in Alberta was previously known as the eastern short-horned lizard (*Phrynosoma douglassii brevirostre*), one of several subspecies within the larger short-horned lizard species (*Phrynosoma douglassii*) grouping (Reeve 1952, Russell and Bauer 1993, Baur and Montanucci 1998). Analysis of the mitochondrial DNA of short-horned lizards from across most of their distribution, including some samples from Alberta, suggested that the short-horned lizard grouping be subdivided into two separate species (Zamudio et al. 1997). Those populations in the Pacific Northwest, primarily in the Columbia River drainage, were reclassified as *Phrynosoma douglasii*, the pygmy short-horned lizard. The remainder of the grouping—those populations south and east of the Rocky Mountains, on the Great Plains, and on the Colorado Plateau—was subsumed into *Phrynosoma hernandesi*, and retained the "short-horned lizard" designation (Zamudio 1997, Smith et al. 1999, Crother 2000). There was little support for subspecific divisions within *P. hernandesi* by Zamudio et al. (1997). However, Crother (2000) suggested the subspecific name of *Phrynosoma hernandesi hernandesi* be maintained for those populations that range throughout the United States and Canada (but not those in Mexico) until the status of the taxon is addressed explicitly. Reeder and Montanucci (2001) suggested that the overall phylogeny of *Phrynosoma* is still unresolved and that these relationships should be considered uncertain until new data are put forward. To further complicate matters, while some sources use the common name of short-horned lizard (e.g., Canadian Endangered Species Conservation Council 2001, Sherbrooke 2003), others now refer to *Phrynosoma hernandesi* as the greater short-horned lizard (e.g., Crother 2000, COSEWIC 2003, NatureServe 2003, Stebbins 2003), whereas Russell and Bauer (2000) term *Phrynosoma hernandesi* in Alberta as the mountain short-horned lizard (acknowledged in Stebbins 2003). Given this discord on names, the species in Alberta will simply be referred to as the short-horned lizard (*Phrynosoma hernandesi*) until a consensus is reached.

STATUS HISTORY

A provincial review of the status of fish and wildlife species in 1984 described the short-horned lizard in Alberta as *Threatened* (Alberta Fish and Wildlife 1984). In 1985, an Alberta government report placed the short-horned lizard on the list of species considered to be peripheral to the province (Alberta Fish and Wildlife 1985). In 1991, the species was described as being "rare and localized," and was included on the "Red List" as a species considered to be at immediate risk of declining to nonviable levels (Alberta Forestry, Lands and Wildlife 1991). Short-horned lizards were eventually moved to the provincial "Blue List" of species that may be at risk in the province (Alberta Wildlife Management Division 1996). The "Blue List" referred to species that "may be at risk due to non-cyclical population declines, or reductions in habitat or provincial distribution" (Alberta Wildlife Management Division 1996). A 1994 Committee on the Status of Endangered Wildlife in Canada (COSEWIC) report categorized short-horned lizards on the prairies as *Vulnerable* (Powell and Russell 1992b, 1998; Anonymous 1994)—a designation that has recently been renamed as the *Special Concern* category (COSEWIC 2003).

CURRENT STATUS

1. Alberta. – The short-horned lizard is legally designated as a *Non-game Animal* under Schedule 4, Part 5 of the *Wildlife Regulation* section of the Alberta *Wildlife Act* (Province of Alberta 2003). Animals included in this designation are provided with full protection and may not be killed, possessed, bought or sold without a permit. *The General Status of Alberta Wild Species 2000* lists short-horned lizards in the *May Be At Risk* category, meaning "any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment" (Alberta Sustainable Resource Development 2001). The Alberta

Natural Heritage Information Network (2002) ranks *Phrynosoma hernandesi* as S2 (provincially). The provincial S2 ranking refers to a species with "6-20 or fewer occurrences or with many individuals in fewer locations" that "may be especially vulnerable to extirpation because of some factor of its biology" (Alberta Natural Heritage Information Network 2002). There is no formal protection of short-horned lizard habitat in Alberta beyond that associated with public lands (J. Nicholson, pers. comm.).

2. Other Areas. – COSEWIC (2003) has classified *Phrynosoma hernandesi* as a species of *Special Concern* in Canada. This status was assigned because current populations are "...apparently small, may be declining (Alberta), and restricted to pockets of favourable habitat" (COSEWIC 2003). The document *Wild Species 2000: The General Status of Species in Canada*, categorizes short-horned lizards as *May Be At Risk* in Alberta and as *Sensitive* in Saskatchewan (Canadian Endangered Species Conservation Council 2001). Short-horned lizards are listed under Schedule 3 of the federal *Species at Risk Act* (Government of Canada 2003). *Phrynosoma hernandesi* is listed as having a Global Heritage Status Rank of G5 and a National Heritage Status Rank of N5 (secure) in the United States. The G5 ranking means that it is considered "demonstrably secure" with "typically > 100 occurrences" across its international distribution. In Canada the species has a status of N2N3 meaning it ranks between "imperilled" and "vulnerable" (NatureServe 2003).

In Saskatchewan, short-horned lizards are ranked provincially as S2S3 with S2 denoting "rare" and S3 meaning "rare-uncommon" (Saskatchewan Conservation Data Centre 2001). Under the *Wildlife Act* of Saskatchewan, short-horned lizards may not be collected in that province without a licence (Anonymous 1998). As short-horned lizards in Saskatchewan are restricted within the bounds of Grasslands National Park, they are additionally protected through the *National Parks Act* (G.L. Powell, pers. comm.).

In Montana—the state adjacent to both the Alberta and Saskatchewan populations—*Phrynosoma hernandesi* is ranked as S3, or "vulnerable," by the Montana Natural Heritage Program (Carlson 2003). This ranking is further defined as "either very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout its range because of other factor(s)" (Carlson 2003).

RECENT MANAGEMENT IN ALBERTA

No direct management of short-horned lizard populations or habitat has been undertaken in Alberta. However, there have been several research studies that have investigated many aspects of the biology, range and ecology of the species in this province. These studies (Powell 1982; Powell and Russell 1984, 1985a,b, 1991a,b, 1992a,b, 1993a,b, 1994, 1996a,b, 1998; Smith 1993; James 2002, 2003) have served to greatly increase the understanding of this species in Alberta, and may in turn contribute to the direction of any management in the future.

While studying population trends of the short-horned lizard in Alberta, Powell and Russell (1992a, 1993a) also attempted to examine the status of populations over the known range in Alberta. Smith (1993) investigated the habitat and status of the populations in one area of the range subject to substantial oil and gas development—the Manyberries badlands. Next, a three-year study of the home range size and overwintering strategy in the Manyberries Creek valley was undertaken using radiotelemetry (Powell and Russell 1992a, 1993a). Important data on habitat use and yearly activity patterns were obtained (Powell and Russell 1993b, 1994), and new suggestions were made concerning the suspected cause of the limited range of the species in Alberta, updating previous theories (Powell and Russell 1985a, 1991a,b 1993a, 1996b, 1998). Over the field seasons of 1994-1995, James used thermally sensitive radiotelemetry to investigate the thermal patterns

of gravid and non-gravid female short-horned lizards over their entire active season (James 1997). As well as determining the thermal patterns exhibited by reproductive females, a notable amount of additional information regarding hibernation, courtship behaviour, movement patterns and predation was gleaned (James 1997). Most recently, field surveys of all lizard populations were undertaken in 2001-2002 to investigate the distribution and population trends of short-horned lizards in Alberta (James 2002, 2003).

Guidelines for land use in potential short-horned lizard habitat suggest restricting activity throughout the year near areas of suitable habitat to no closer than 100 m for all types of development activities. This includes such activities as short- and long-term vegetation or soil disturbance and structure creation (Alberta Fish and Wildlife Division 2001). It is recommended that these 100 m guidelines be strictly adhered to in spite of lesser distances set forth in a previous report (James 2002). Specific guidelines for seismic operations within the Manyberries badlands have also been developed and are available on the Fish and Wildlife website (at http://www3.gov.ab.ca/srd/fw/landuse/pdf/GrasslandParkland.pdf). These guidelines, which are not enforceable laws, are applied on a site-specific basis (J. Nicholson, pers. comm.). The guidelines recommend that any disturbance within the habitat, such as access by foot or helicopter, should be minimal and occur only during the non-active months of November through March (J. Taggart, pers. comm.). J. Nicholson (pers. comm.) has observed that much of the development in the Manyberries area has occurred without the use of these guidelines, but also that there has been some input from the Fish and Wildlife Division at various stages of development.

A significant amount of oil and gas development occurs within the range of the short-horned lizard in Alberta (Powell and Russell 1991b, 1992a,b, 1993a, 1996b, 1998; Smith 1993). Many companies have made efforts to reduce the potential impact of their operations on short-horned lizards and other rare species in this area. As an early example of this, Samedan Oil of Canada made several provisions to reduce the impact of exploration, and made efforts to reclaim the habitat disturbed by the project (Hornbeck and Green 1990, 1991; New 1991). More recently (2002-2003), a few seismic programs in critical short-horned lizard habitat have been accomplished on foot or using an all-terrain vehicle or helicopter, rather than by more intrusive means (J. Nicholson, pers. comm.). As well, an experienced biologist has been employed to locate any short-horned lizards within the area of direct impact and move them a safe distance away (J. Nicholson, J. Taggart, pers. comm.). Such efforts will aid the survival of these populations by reducing the overall disturbance caused by seismic developments.

SYNTHESIS

In Alberta, the short-horned lizard is at the northern edge of its range, and occurs in a limited number of areas in the extreme southeastern region of the province. Populations are at relatively low densities, and are probably limited by natural factors such as climate. Human-related factors such as agricultural practices, oil and gas development, urbanization and road construction, and off-road recreational traffic also have a negative effect on short-horned lizard populations.

The limited distribution, small population size and potential threats to existing habitat make the short-horned lizard susceptible to population declines in Alberta. In fact, there is some limited evidence to suggest that such declines have already occurred over the past 20 years. Repeated surveys at fixed localities will be required to confirm this suspected trend. Such surveys, if supplemented by research techniques (e.g., telemetry and marking), could also allow the collection of more detailed information on the population biology of this species. Further

research is required to more adequately define potential threats to the persistence of short-horned lizard populations in Alberta. However, inexpensive, brief annual surveys alone would also serve to clarify the population status.

LITERATURE CITED

Achuff, P.L. 1992. Natural Regions, Subregions and Natural History Themes of Alberta: a classification for protected areas management. Report No. 2. Prepared for Parks Services and Natural and Protected Areas, Alberta Government. Revised and updated December 1994.

Alberta Environmental Protection. 1996. The status of Alberta wildlife. Alberta Environmental Protection, Natural Resources Service, Wildlife Management Division. Edmonton, AB. 44 pp.

Alberta Environmental Protection. 1997. The Grassland Natural Region of Alberta. Natural Resources Service, Recreation and Protected Areas Division, Natural Heritage Protection and Education Branch. 229 pp.

Alberta Fish and Wildlife. 1984. Status of the fish and wildlife resource in Alberta. Alberta Fish and Wildlife, Edmonton, AB. 123 pp.

Alberta Fish and Wildlife. 1985. A policy for the management of threatened wildlife in Alberta. Alberta Fish and Wildlife, Edmonton, AB. 34 pp.

Alberta Fish and Wildlife Division. 2001. Recommended landuse guidelines for protection of selected wildlife species and habitat within Grassland and Parkland natural regions of Alberta. Sustainable Resource Development, Government of Alberta, Edmonton, Alberta. URL: http://www3.gov.ab.ca/srd/fw/landuse/#guidelines [Last draft updated 26 July 2001; Accessed 16 October 2003]

Alberta Forestry, Lands and Wildlife. 1991. The status of Alberta wildlife. Alberta Fish and Wildlife, Edmonton, AB. 49 pp.

Alberta Natural Heritage Information Network (ANHIN). 2002. Reptile Tracking List.[Last updated 29 October 2002] Explanation of Ranks [Last updated 9 October 2002] Alberta Natural Heritage Information Centre (ANHIC). URL: http://www.cd.gov.ab.ca/preserving/parks/anhic/ [Accessed: 10 October 2003]

Alberta Natural Heritage Information Centre (ANHIC). 2002. Rank Definitions. URL: http://www.cd.gov.ab.ca/preserving/parks/anhic/definitions.asp [Last Updated: October 2002].

Alberta Wildlife Management Division. 1996. The status of Alberta wildlife. Alberta Natural Resources Service, Edmonton, AB. 44 pp.

Alberta Sustainable Resource Development. 2001. The general status of Alberta wild species 2000. Alberta Sustainable Resource Development, Fish and Wildlife Service, Edmonton, AB. 46 pp. [Also available at: http://www3.gov.ab.ca/srd/fw/riskspecies/speciesatrisk/index.html]

Anonymous. 1994. Endangered species in Canada (and other wildlife at risk). List of species at risk in Canada as determined by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). World Wildlife Fund Canada, Toronto, ON. 2 pp.

Anonymous. 1998. The Wildlife Act. W-13.12 Statutes of Saskatchewan, 1998 as amended by the Statutes of Saskatchewan 2000, c. 51 and 65. The

Queen's Printer. Regina, Saskatchewan. 61 pp.

Baur, B., and R.R. Montanucci. 1998. Krötenechsen. Offenbach: Herpeton, Verlag Elke Köhler, Munich. 158 pp.

Beauchamp, B., B. Wone, S. Bros and M. Kutilek. 1998. Habitat use of the flat-tailed horned lizard (*Phrynosoma mcallii*) in a disturbed environment. Journal of Herpetology 32:210-216.

Blackburn, D.G. 1982. Evolutionary origins of viviparity in the Reptilia. I. Sauria. Amphibia. Reptilia 3:185-205.

Canadian Endangered Species Conservation Council. 2001. Wild species 2000: the general status of species in Canada. Ottawa: Minister of Public Works and Government Services Canada. URL: http://www.wildspecies.ca/wildspecies2000/ [Last updated 10/06/03; Accessed: 16 October 2003]

Carlson, J. 2003. Coordinator, Montana Animal Species of Concern Committee. Montana Animal Species of Concern: Watch Lists. Montana Natural Heritage Program and Montana Fish Wildlife and Parks. Helena, Montana. 14pp. URL: http://nris.state.mt.us/mtnhp/ [Last updated January 2003, Accessed: 10 October 2003]

COSEWIC. 2003. Database. Committee on the Status of Endangered Wildlife in Canada. URL: http://www.cosewic.gc.ca/eng/sct1/searchdetail_e.cfm [Last updated: 19 August 2003; Accessed 16 October 2003]

Crother, B.I., editor. 2000. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. SSAR Herpetological Circular No. 29. 82 pp.

Government of Canada. 2003. Species at Risk Act Public Registry. Species List. URL: http://www.sararegistry.gc.ca/species/species [Last updated 2003-10-08; Accessed 10 October 2003]

Halladay, I.R. 1965. Recent biota of the Cypress Hills Plateau. A general survey of the natural history. Pp. 37-54 in Zell, R.L. (ed.). Alberta Society of Petroleum Geologists 15th Annual Field Conference Guide, Part 1. 288 pp.

Heath, J.E. 1964. Head-body temperature differences in horned lizards. Physiological Zoology 37:273.

Heath, J.E. 1965. Temperature regulation and diurnal activity in horned lizards. University of California Press, Berkeley and Los Angeles, California. 135 pp.

Hornbeck, G.E., and J.E. Green. 1990. A reconnaissance field survey of the eastern short-horned lizard and its habitat in Samedan Manyberries 9-13-4-5 W4M. Delta Environmental Management Group Ltd. Calgary, AB. 27 pp.

Hornbeck, G.E., and J.E. Green. 1991. Year two (1991) of a reconnaissance field survey of the eastern short-horned lizard and its habitat in Samedan Manyberries 9-13-4-5 W4M. Delta Environmental Management Group Ltd. Calgary, AB. 17 pp.

Hunter, M. L. Jr. 1996. Fundamentals of conservation biology. Blackwell Science, Cambridge, Massachusetts, USA. 482 pp.

James, J.D. 1997. Pre- and post-parturition thermoregulation in free-ranging female eastern short-horned lizards (*Phrynosoma douglassii brevirostre*) in southeastern Alberta. Unpublished Masters thesis. University of Calgary. Calgary, AB. 179 pp.

James, J.D. 2002. A survey of short-horned lizard (*Phrynosoma hernandesi hernandesi*) populations in Alberta. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 29. Edmonton, AB. 25 pp.

James, J.D. 2003. Short-horned lizard (*Phrynosoma hernandesi hernandesi*) populations in Alberta – 2002 survey results. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 65. Edmonton, AB. 7 pp.

Laird, M., and R. Leech. 1980. Observations of the short-horned lizard in southeastern Alberta. Blue Jay 39:214-218.

Lewin, V. 1963. The herpetofauna of southeastern Alberta. Canadian Field-Naturalist 77:203-214.

McCorquedale, B. 1965. Some peculiar aspects of the biota of the Cypress Hills. Pp. 55-65 in Zell, R.L. (ed.). Alberta Society of Petroleum Geologists 15th Annual Field Conference Guide, Part 1. 288 pp.

Milner, B.J. 1979. Northern short-horned lizard in southeastern Alberta. Alberta Naturalist 9:90-92.

Montanucci, R.R. 1981. Habitat separation between *Phyrnosoma douglassii* and *P. orbicular* (Lacertila: Iguanidae) in Mexico. Copeia 1981:147-153.

Montanucci, R.R. 1987. A phylogenetic study of the horned lizards, genus *Phrynosoma*, based on skeletal and external morphology. Contributions in Science. Natural History Museum of Los Angeles County, Los Angeles. No. 390:1-36.

National Research Council. 1995. Science and the Endangered Species Act. National Academy Press, Washington, DC. 271 pp.

NatureServe. 2003. NatureServe Explorer: An online encyclopedia of life [web application]. 2001. Version 1.8. Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer [Last Updated October 2002, Accessed: 14 October 2003]

New, E.R. 1991. Drilling in short-horned lizard country. Abstract presented at the CADE/CAODC Spring Drilling Conference, April 10-12, 1991. CADE/CAODC Conference Publications. Calgary, AB.

Pianka, E.R. 1966. Convexity, desert lizards and spatial heterogeneity. Ecology 47:1055-1059.

Pianka, E.R., and W.S. Parker. 1975. Ecology of horned lizards: a review with special reference to *Phrynosoma platyrhinos*. Copeia 1975:141-162.

Powell, G.L. 1982. The eastern short-horned lizard in Alberta: basic field ecology of northern marginal populations. Unpublished M.Sc. thesis, University of Calgary, Calgary, AB. 343 pp.

Powell, G.L. and A.P. Russell. 1984. The diet of the eastern short-horned lizard (*Phrynosoma douglassii brevirostre*) in Alberta and its relationship to sexual size

dimorphism. Canadian Journal of Zoology 62:428-440.

Powell, G.L., and A.P. Russell. 1985a. Field thermal ecology of the eastern short-horned lizard (*Phrynosoma douglassii brevirostre*) in southeastern Alberta. Canadian Journal of Zoology 63:228-238.

Powell, G.L., and A.P. Russell. 1985b. Growth and sexual size dimorphism in Alberta populations of the eastern short-horned lizard, *Phrynosoma douglassii brevirostre*. Canadian Journal of Zoology 63:139-154.

Powell, G.L., and A.P. Russell. 1991a. Parturition and clutch size characteristics of short-horned lizards (*Phrynosoma douglassii brevirostre*) from Alberta. Canadian Journal of Zoology 69:2759-2764.

Powell, G.L., and A.P. Russell. 1991b. Distribution of the eastern short-horned lizard (*Phrynosoma douglassii brevirostre*) in Alberta, Canada. Northwestern Naturalist 72:21-26.

Powell, G.L., and A.P. Russell. 1992a. A preliminary survey of the distribution and abundance of the eastern short-horned lizard (*Phrynosoma douglassii brevirostre*) in Alberta. Unpublished report to The Recreation, Parks and Wildlife Foundation, Edmonton, AB. 135 pp.

Powell, G.L., and A.P. Russell. 1992b. The status of the short-horned lizard (*Phrynosoma douglassii*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. 22 pp.

Powell, G.L., and A.P. Russell. 1993a. The range and status of the eastern short-horned lizard in the Canadian prairies. Pp. 278-290 in Holroyd, G.L., H.L. Dickson, M. Regnier and H.C. Smith (eds.). Proceedings of the 3rd prairie conservation and endangered species workshop. Provincial Museum of Alberta Natural History Occasional Paper No. 19, Edmonton, AB. 384 pp.

Powell, G.L., and A.P. Russell. 1993b. A radio telemetric study of movement and thermal ecology in an Alberta population of the eastern short-horned lizard (*Phrynosoma douglassii brevirostre*). Unpublished report to Alberta Fish and Wildlife Division, Lethbridge, AB. 74 pp.

Powell, G.L., and A.P. Russell. 1994. A radio telemetric study of movement, thermal ecology and hibernation site selection in an Albertan population of the eastern short-horned lizard (*Phrynosoma douglassii brevirostre*). Unpublished report to Alberta Fish and Wildlife Division, Lethbridge, AB. 132 pp.

Powell, G.L., and A.P. Russell. 1996a. Alberta's amphibians and reptiles: current research and conservation issues. Pp. 253-255 in Willms, W.D., and J.F. Dormaar (eds.). Proceedings of the fourth prairie conservation and endangered species workshop. Provincial Museum of Alberta Natural History Occasional Paper No. 23, Edmonton, AB. 337 pp.

Powell, G.L., and A.P. Russell. 1996b. Movement, thermal ecology, seasonal activity, and overwintering behaviour in an Alberta population of the eastern short-horned lizard (*Phrynosoma douglassii brevirostre*). Alberta Fish and Wildlife Division, Lethbridge, AB. 128 pp.

Powell, G.L., and A.P. Russell. 1996c. Eastern short-horned lizards (*Phrynosoma douglassii brevirostre*) in Grasslands National Park: a report on the 1995 field season. Unpublished report, Parks Canada, Val Marie, SK. 74 pp.

Powell, G.L., and A.P. Russell. 1998. The status of short-horned lizards, *Phrynosoma douglasi* and *P. hernandezi*, in Canada*. Canadian Field-Naturalist 112(1):1-16.

Powell, G.L., A.P. Russell and P. Fargey. 1998. The distribution of the short-horned lizard *Phrynosoma hernandezi* in Saskatchewan, Canada. Northwest Naturalist 79:19-26.

Prieto, A.A., Jr., and W.G. Whitford. 1971. Physiological responses to temperature in the horned lizards *Phrynosoma cornutum* and *Phrynosoma douglassii*. Copeia 1971:498-504.

Province of Alberta. 2003. Wildlife Act (Statutes of Alberta, 1984, Chapter W-9.1 with amendments in force as of 2003) and Wildlife Regulation (Alberta Regulation 143/97 with amendments up to and including Alberta Regulation 291/2003). Queen's Printer for Alberta. 53 and 271 pp. URL: http://www.qp.gov.ab.ca/document_print.cfm [Accessed online: 16 October 2003]

Reeder, T.W., and R.R. Montanucci. 2001. Phylogenetic analysis of the horned lizards (Phrynostomatidae: Phrynosoma): evidence from mitochondrial DNA and morphology. Copeia 2001:309-323.

Reeve, W.L. 1952. Taxonomy and distribution of the horned lizards genus *Phrynosoma*. University of Kansas Scientific Bulletin 34:817-960.

Reichel, J., and D. Flath. 1995. Identification of Montana's amphibians and reptiles. Montana Outdoors, May/June, 1995. 19 pp.

Reynolds, W.L. 1979. Response of reptile populations to different land management practices on the Idaho National Engineering Laboratory site. Great Basin Naturalist 39:255-262.

Russell, A.P., and A.M. Bauer. 1993. The amphibians and reptiles of Alberta. University of Calgary and University of Alberta Presses, Calgary and Edmonton, AB. 264 pp.

Russell, A.P., and A.M. Bauer. 2000. The amphibians and reptiles of Alberta. A field guide and primer of boreal herpetology. Second Edition. University of Calgary Press, Calgary, AB. 279 pp.

Saskatchewan Conservation Data Centre. 2001. Vertebrate Species Lists. URL: http://www.biodiversity.sk.ca/FTP.htm [Accessed: 10 October 2003]

Sherbrooke, W.C. 2003. Introduction to horned lizards of North America. University of California Press, Berkely, CA. 178 pp.

Smith, H.M. 1946. Handbook of lizards. Comstock Publishing, Ithaca, NY. 557 pp.

Smith, W. 1993. An assessment of short-horned lizard habitat and use, Manyberries badlands, Alberta. Unpublished report to Alberta Fish and Wildlife, Lethbridge, AB. 63 pp.

Smith, H.M., K. Adler, D. Chiszar and F. van Breukelen. 1999. *Phrynosoma hernandesi*: correct spelling. Herpetological Review 30: 74-76.

Soper, J.D. 1949. Notes on the fauna of the former Nemiskam National Park and vicinity, Alberta. Canadian Field-Naturalist 63: 167-182.

Stebbins, R.C. 2003. A field guide to western reptiles and amphibians. Third Edition. Houghton Mifflin Co., Boston, MA. 533 pp.

Wallis, C. 1976. Milk River Canyon resource evaluation. Alberta Recreation, Parks and Wildlife, Edmonton, AB. 122 pp.

Williams, M.Y. 1946. Notes on the vertebrates of the southern plains of Canada, 1923-26. Canadian Field-Naturalist 60: 47-60.

Zamudio, K.R., K.B. Jones and R.H. Ward. 1997. Molecular systematics of short-horned lizards: biogeography and taxonomy of a widespread species complex. Systematic Biology 46(2): 284-305.

Appendix 1. Definitions of selected legal and protective designations.

A. The General Status of Alberta Wild Species 2000 (after Alberta Sustainable Resource Development 2001)

2000 Rank	1996 Rank	Definitions
At Risk	Red	Any species known to be *At Risk* after formal detailed status assessment and designation as *Endangered* or *Threatened* in Alberta.
May Be At Risk	Blue	Any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment.
Sensitive	Yellow	Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk.
Secure	Green	Any species that is not *At Risk*, *May Be At Risk* or *Sensitive*.
Undetermined	Status Undetermined	Any species for which insufficient information, knowledge or data is available to reliably evaluate its general status.
Not Assessed	n/a	Any species known or believed to be present but which has not yet been evaluated.
Exotic/Alien	n/a	Any species that has been introduced as a result of human activities.
Extirpated/Extinct	n/a	Any species no longer thought to be present in Alberta (*Extirpated*) or no longer believed to be present anywhere in the world (*Extinct*).
Accidental/Vagrant	n/a	Any species occurring infrequently and unpredictably in Alberta, i.e., outside its usual range.

B. Alberta Wildlife Act/Regulation

Species designated as *Endangered* under Alberta's *Wildlife Act* include those listed as *Endangered* or *Threatened* in the Wildlife Regulation.

Endangered	A species facing imminent extirpation or extinction.
Threatened	A species that is likely to become endangered if limiting factors are not reversed.

C. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 2003)

Extinct	A species that no longer exists.
Extirpated	A species that no longer exists in the wild in Canada, but occurs elsewhere.
Endangered	A species facing imminent extirpation or extinction.
Threatened	A species that is likely to become endangered if limiting factors are not reversed.
Special Concern	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Not at Risk	A species that has been evaluated and found to be not at risk.
Data Deficient	A species for which there is insufficient scientific information to support status designation.

Appendix 1 continued.

D. Heritage Status Ranks: Global (G), National (N), Sub-National (S) (after Alberta Natural Heritage Information Centre 2002)

G1/N1/S1	5 or fewer occurrences or only a few remaining individuals. May be especially vulnerable to extirpation because of some factor of its biology.
G2/N2/S2	6 to 20 or fewer occurrences or with many individuals in fewer locations. May be especially vulnerable to extirpation because of some factor of its biology.
G3/N3/S3	21 to 100 occurrences, may be rare and local throughout its range, or in a restricted range (may be abundant in some locations). May be susceptible to extirpation because of large-scale disturbances.
G4/N4/S4	Typically > 100 occurrences. Apparently secure.
G5/N5/S5	Typically > 100 occurrences. Demonstrably secure.
GX/NX/SX	Believed to be extinct or extirpated, historical records only.
GH/NH/SH	Historically known, may be relocated in the future.
GR/NR/SR	Reported, but lacking in documentation or not considered at risk and hence not a priority for ranking.

E. United States Endangered Species Act (after National Research Council 1995)

Endangered	Any species which is in danger of extinction throughout all or a significant portion of its range.
Threatened	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Appendix 2. Generalized subpopulation localities with comments on approximate distribution and perceived population density.

Approximate subpopulation location	**Approximate # of sections within site area**	**General habitat description**	**Perceived population density in 2001/2002**
South Saskatchewan River sites	13	South-facing slopes along coulees near river, occasional sightings in grasslands nearby.	Low
Foremost / Chin Coulee sites	7	Along ecotone between grassland and coulee bottom.	Low
Manyberries Badlands sites	21	Juniper-dunes / Bearpaw shale area; ecotone between lowland and upper grasslands.	Highest
Milk River sites	8	Upper reaches of coulee and canyon edges with southern exposure.	Low
Comrey / Onefour / Lost River sites	19	Upper reaches of coulee and canyon edges with southern exposure; occasional sightings in nearby grasslands	Unverified / extremely low

List of Titles in This Series
(as of June 2004)

No. 1 Status of the Piping Plover (*Charadrius melodus*) in Alberta, by David R. C. Prescott. 19 pp. (1997)

No. 2 Status of the Wolverine (*Gulo gulo*) in Alberta, by Stephen Petersen. 17 pp. (1997)

No. 3 Status of the Northern Long-eared Bat (*Myotis septentrionalis*) in Alberta, by M. Carolina Caceres and M. J. Pybus. 19 pp. (1997)

No. 4 Status of the Ord's Kangaroo Rat (*Dipodomys ordii*) in Alberta, by David L. Gummer. 16 pp. (1997)

No. 5 Status of the Eastern Short-horned Lizard (*Phrynosoma douglassii brevirostre*) in Alberta, by Janice D. James, Anthony P. Russell and G. Lawrence Powell. 20 pp. (1997)

No. 5 Update 2004. Status of the Short-horned Lizard (*Phrynosoma hernandesi*) in Alberta. Alberta Sustainable Resource Development. 27 pp. (2004)

No. 6 Status of the Prairie Rattlesnake (*Crotalus viridis viridis*) in Alberta, by Sheri M. Watson and Anthony P. Russell. 26 pp. (1997)

No. 7 Status of the Swift Fox (*Vulpes velox*) in Alberta, by Susan E. Cotterill. 17 pp. (1997)

No. 8 Status of the Peregrine Falcon (*Falco peregrinus anatum*) in Alberta, by Petra Rowell and David P. Stepnisky. 23 pp. (1997)

No. 9 Status of the Northern Leopard Frog (*Rana pipiens*) in Alberta, by Greg Wagner. 46 pp. (1997)

No. 9 Update 2003. Status of the Northern Leopard Frog (*Rana pipiens*) in Alberta. Alberta Sustainable Resource Development. 61 pp. (2003)

No. 10 Status of the Sprague's Pipit (*Anthus spragueii*) in Alberta, by David R. C. Prescott. 14 pp. (1997)

No. 11 Status of the Burrowing Owl (*Speotyto cunicularia hypugaea*) in Alberta, by Troy I. Wellicome. 21 pp. (1997)

No. 12 Status of the Canadian Toad (*Bufo hemiophrys*) in Alberta, by Ian M. Hamilton, Joann L. Skilnick, Howard Troughton, Anthony P. Russell, and G. Lawrence Powell. 30 pp. (1998)

No. 13 Status of the Sage Grouse (*Centrocercus urophasianus urophasianus*) in Alberta, by Cameron L. Aldridge. 23 pp. (1998)

No. 14 Status of the Great Plains Toad (*Bufo cognatus*) in Alberta, by Janice D. James. 26 pp. (1998)

No. 15 Status of the Plains Hognose Snake (*Heterodon nasicus nasicus*) in Alberta, by Jonathan Wright and Andrew Didiuk. 26 pp. (1998)

No. 16 Status of the Long-billed Curlew (*Numenius americanus*) in Alberta, by Dorothy P. Hill. 20 pp. (1998)

No. 17 Status of the Columbia Spotted Frog (*Rana luteiventris*) in Alberta, by Janice D. James. 21 pp. (1998)

No. 18 Status of the Ferruginous Hawk (*Buteo regalis*) in Alberta, by Josef K. Schmutz. 18 pp. (1999)

No. 19 Status of the Red-tailed Chipmunk (*Tamias ruficaudus*) in Alberta, by Ron Bennett. 15 pp. (1999)

No. 20 Status of the Northern Pygmy Owl (*Glaucidium gnoma californicum*) in Alberta, by Kevin C. Hannah. 20 pp. (1999)

No. 21 Status of the Western Blue Flag (*Iris missouriensis*) in Alberta, by Joyce Gould. 22 pp. (1999)

No. 22 Status of the Long-toed Salamander (*Ambystoma macrodactylum*) in Alberta, by Karen L. Graham and G. Lawrence Powell. 19 pp. (1999)

No. 23 Status of the Black-throated Green Warbler (*Dendroica virens*) in Alberta, by Michael R. Norton. 24 pp. (1999)

No. 24 Status of the Loggerhead Shrike (*Lanius ludovicianus*) in Alberta, by David R. C. Prescott and Ronald R. Bjorge. 28 pp. (1999)

No. 25 Status of the Plains Spadefoot (*Spea bombifrons*) in Alberta, by Richard D. Lauzon. 17 pp. (1999)

No. 26 Status of the Trumpeter Swan (*Cygnus buccinator*) in Alberta, by M. Lynne James. 21 pp. (2000)

No. 27 Status of the Pygmy Whitefish (*Prosopium coulteri*) in Alberta, by William C. Mackay. 16 pp. (2000)

No. 28 Status of the Short-eared Owl (*Asio flammeus*) in Alberta, by Kort M. Clayton. 15 pp. (2000)

No. 29 Status of the Willow Flycatcher (*Empidonax traillii*) in Alberta, by Bryan Kulba and W. Bruce McGillivray. 15 pp. (2001).

No. 30 Status of the Woodland Caribou (*Rangifer tarandus caribou*) in Alberta, by Elston Dzus. 47 pp. (2001)

No. 31 Status of the Western Spiderwort (*Tradescantia occidentalis*) in Alberta, by Bonnie Smith. 12 pp. (2001)

No. 32 Status of the Bay-breasted Warbler (*Dendroica castanea*) in Alberta, by Michael Norton. 21 pp. (2001)

No. 33 Status of the Cape May Warbler (*Dendroica tigrina*) in Alberta, by Michael Norton. 20 pp. (2001)

No. 34 Status of the Whooping Crane (*Grus americana*) in Alberta, by Jennifer L. White. 21 pp. (2001)

No. 35 Status of Soapweed (*Yucca glauca*) in Alberta, by Donna Hurlburt. 18 pp. (2001)

No. 36 Status of the Harlequin Duck (*Histrionicus histrionicus*) in Alberta, by Beth MacCallum. 38 pp. (2001)

No. 37 Status of the Grizzly Bear (*Ursus arctos*) in Alberta, by John L. Kansas. 43 pp. (2002)

No. 38 Status of the Wood Bison (*Bison bison athabascae*) in Alberta, by Jonathan A. Mitchell and C. Cormack Gates. 32 pp. (2002)

No. 39 Status of the Bull Trout (*Salvelinus confluentus*) in Alberta, by John R. Post and Fiona D. Johnston. 40 pp. (2002)

No. 40 Status of the Banff Springs Snail (*Physella johnsoni*) in Alberta, by Dwayne A.W. Lepitzki. 29 pp. (2002)

No. 41 Status of the Shortjaw Cisco (*Coregonus zenithicus*) in Alberta, by Mark Steinhilber. 23 pp. (2002)

No. 42 Status of the Prairie Falcon (*Falco mexicanus*) in Alberta, by Dale Paton. 28 pp. (2002)

No. 43 Status of the American Badger (*Taxidea taxus*) in Alberta, by Dave Scobie. 17 pp. (2002)

No. 44 Status of the Yucca Moth (*Tegeticula yuccasella*) in Alberta. Alberta Sustainable Resource Development. 21 pp. (2002)

No. 45 Status of the White-winged Scoter (*Melanitta fusca deglandi*) in Alberta. Alberta Sustainable Resource Development. 15 pp. (2002)

No. 46 Status of the Lake Sturgeon (*Acipenser fulvescens*) in Alberta. Alberta Sustainable Resource Development. 30 pp. (2002)

No. 47 Status of the Western Silvery Minnow (*Hybognathus argyritis*) in Alberta. Alberta Sustainable Resource Development. 24 pp. (2003)

No. 48 Status of the Small-flowered Sand Verbena (*Tripterocalyx micranthus*) in Alberta. Alberta Sustainable Resource Development. 24 pp. (2003)

No. 49 Status of the Brown Creeper (*Certhia americana*) in Alberta. Alberta Sustainable Resource Development. 30 pp. (2003)

No. 50 Status of the Mountain Plover (*Charadrius montanus*) in Alberta. Alberta Sustainable Resource Development. 25 pp. (2003)

No. 51 Status of the St. Mary Shorthead Sculpin (provisionally *Cottus bairdi punctulatus*) in Alberta. Alberta Sustainable Resource Development. 24 pp. (2004)

No. 52 Status of the Stonecat (*Noturus flavus*) in Alberta. Alberta Sustainable Resource Development. 22 pp. (2004)

No. 53 Status of the Sage Thrasher (*Oreoscoptes montanus*) in Alberta. Alberta Sustainable Resource Development. 23 pp. (2004)